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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/026,537

12/27/2001

Ihl Hyun Cho

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11/28/2003

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EXAMINER

RAO, SHRINIVAS H

ART UNIT

PAPER NUMBER

2814

DATE MAILED: 11/28/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/026,537

Applicant(s)

CHO, IHL HYUN

Examiner

Steven H. Rao

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 25 September 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 9-17 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☐ Claim(s) 9-17 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. §§ 119 and 120**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.  
a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

**Attachment(s)**

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_ 6) ☐ Other: \_\_\_\_\_

***Response to Amendment***

Applicants' amendment filed on September 05, 2003 has been entered on September 23, 2003.

Therefore claims 9-19 as recited in the amendment are currently pending in the Application.

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 9, 11 and 18-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fang et al. (U.S. Patent No. 5,858,844, herein after Fang) in view of Iijima et al. (U.S. Patent NO. 5,903,053, herein after Iijima). ( the previous rejection is reproduced below as Applicants' have not amended the claims , for response to Applicants' Arguments see section below).

With respect to claim 9, Fang describes a method of fabricating a semiconductor device including the steps of: preparing a semiconductor substrate (Fang Fig. 1 A # 14, col. 3 line 15), forming a silicon oxide layer on the semiconductor substrate (Fang fig. 1 A #12, col. 3 line 43-44), forming a conductive layer on the silicon oxide layer (Fang, fig. 1A # 10, col. 3 line 44).

Fang does not specifically teach forming a metal oxide layer with a substantially uniform thickness at an interface between the silicon oxide layer and the conductive layer.

However Iijima in figure 9, etc. and col.13 lines 39-67 describes forming a metal oxide layer with a substantially uniform thickness at an interface between the silicon oxide layer and the conductive layer to form a device with low contact resistance between the upper and lower conductive layers thereby proving conductive layers that do not deteriorate the characteristics of the semiconductor device they are incorporated in to.

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to include Iijima's step of forming a metal oxide layer with a substantially uniform thickness at an interface between the silicon oxide layer and the conductive layer in Fang's method to form a device with low contact resistance between the upper and lower conductive layers thereby proving conductive layers that do not deteriorate the characteristics of the semiconductor device they are incorporated in to.

With respect to claim 11, wherein the conductive layer is a metal layer or a metal nitride layer. (col. 1 lines 25-30).

With respect to claim 18, wherein the step of forming the metal oxide layer comprises of forming the metal oxide with oxygen atoms from the silicon oxide layer (Fang col. 3 lines 18-30).

With respect to claim 19, wherein the silicon oxide layer is a gate insulator and the conductive layer is a gate electrode (Fang col. 3 line 14).

For response to Applicants' arguments see Response to arguments section below.

**B.** Claims 10, 12-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fang et al. (U.S. Patent No. 5,858,844, herein after Fang) as applied to claim 1 above, and further in view of Microchip Fabrication Text book. (herein after Van Zant) as previously applied and further in view of Iijima newly applied (as applied to independent claim 9 above).

With respect to claim 10, wherein the silicon oxide layer has a thickness of 10-100 Å<sup>0</sup> Fang teaches a silicon oxide layer without specifying its thickness.

However, Microchip Fabrication, a textbook by Peter Van Zant (McGraw Hill, fourth edition) pages 511-514 in page 513 describes gate oxide thickness in the range of 100-300 Å<sup>0</sup> to control the threshold voltage.

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to form a silicon oxide layer having a thickness of 10-100 Å<sup>0</sup> because it was previously done in the overlapping range of 100-300 Å<sup>0</sup> to form a device with the desired threshold voltage.

With respect to claims 12 and 13, wherein the metal layer comprises of at least one metal selected from a group consisting of Tungsten (W), tantalum (Ta), Titanium (Ti) and Aluminum (Al). (Van Zant page 403 the motivation to combine Van Zant and Fang stated above) for nitride (see claim 11 above).

With respect to claim 14, wherein the conductive layer is 100-2000 Å<sup>0</sup> (Van Zant page 513, gate thickness 60-90 angstroms).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to form a silicon oxide layer having a thickness of 10-100 Å<sup>0</sup> because it was previously done in the overlapping range of 160-90 Å<sup>0</sup> to form a device with speed and other characteristics.

With respect to claim 15, wherein the step of forming the interface includes a thermal treatment at a temperature of 500-100 degrees under inert gas ambient. ( Fang claim 1 step 3 850-900 degrees).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention because includes a thermal treatment at a temperature of 500-100 degrees under inert gas ambient. it was previously done in the overlapping range of 850-900 ° to form a device with highest saturation threshold voltage (Fang col. 4 lines 15-20).

With respect to claim 16, wherein the inert gas is selected from Nitrogen, Argon and Helium ( Van Zant page 413 use of Argon to maintain film composition).

With respect to claim 17, wherein the metal oxide layer formed has a dielectric constant of at least 3.9 .( it is an inherent property of metal oxides mentioned namely Tungsten ( W), tantalum ( Ta) , Titanium ( Ti) oxides to have a dielectric constant of 3.9 or more).

For response to Applicants' arguments see Response to arguments section below.

### ***Response to Arguments***

Applicant's arguments with respect to claims 9 to 19 have been considered but are not persuasive for the following reasons:

It is noted that Applicants' arguments are based on improper piecemeal attacks on references. Applicants' piecemeal analysis of the references ( Fang does not teach a substantially uniform thickness metal oxide layer) and ( Iijima does not teach metal oxide layer formed at the interface between silicon oxide layer and conductive layer), it has been held that one cannot show non-obviousness by attacking references individually where as here, the rejections are based on combinations of references .

See In re Keller , 20-8 USPQ 871 (CCPA 1981).

Applicants' contention that Iijima does not teach or suggest forming a metal oxide layer with ( i) a substantially uniform thickness (ii) located at an interface between the silicon oxide layer and the conductive layer is not persuasive for the following reasons.

Iijima contrary to Applicants' contention teaches a substantially uniformly thick metal oxide, at least in col. 12 lines 27 to 40 ( reproduced below) , etc. ;

In Example 4, as shown in FIG. 7B, the upper surface of a BPSG film 52 is smoothed, and a barrier metal layer 54 is deposited by sputtering on the smoothed surface of the BPSG film 52. The layer 54 therefore has a uniform thickness and can serve as an effective barrier. A barrier metal layer formed by this method can be uniform in thickness even if it is made comparatively thin to provide, as will be demanded in future, wiring layers which have low resistance. In view of this, the method of forming a barrier metal layer, employed in Example 4, is considered advantageous.

The method of forming wiring layers on the smoothed surface of the insulating film will be described in greater detail. First, TiN which has an atomic ratio of Ti to N

Therefore from the above it is clear that Iijima teaches forming a metal oxide layer with ( i ) a substantially uniform thickness for the purpose of forming a barrier film with lower resistance.

Applicants' next contention that Iijima does not teach or suggest a metal oxide located at an interface between the silicon oxide layer and the conductive layer is not persuasive for several reasons :

( a ) Applicants' arguments are consummate in scope with currently recited claim 9 because claim 9 uses the open ended terminology " comprising " which may include other intervening layers between silicon oxide layer and the conductive layer.

( b ) As stated in the rejection Fang discloses a metal oxide located at an interface between the silicon oxide layer and the conductive layer, Fang does not disclose the metal oxide layer to be substantially uniformly thick but Iijima teaches a substantially uniform thickness for the purpose of forming a barrier film with lower resistance.

The combination of Fang and Iijima teaches forming a metal oxide layer with ( i ) a substantially uniform thickness located at an interface between the silicon oxide layer and the conductive layer for the purpose of forming a barrier film with lower resistance.

( c ) Further contrary to Applicants' contention Iijima in col. 13 lines 62-67 states as follows:



used, if necessary. Still further, the wiring layer may be formed on another wiring layer or a semiconductor device, forming a contact therewith, not on an insulating film as in Example 4. Moreover, Example 4 can be applied not only to the formation of a wiring layer, but also to the formation of an electrode.

Therefore in the alternative embodiments stated above Iijima describes a metal oxide layer with (i) a substantially uniform thickness (ii) located at an interface between the silicon oxide layer and the conductive layer.

Therefore all of Applicants' arguments are not persuasive and claim 9 is not allowable.

Applicants' argument that claims 11, 18, 19, 10 and 12-17 are allowable because of their dependency on allegedly allowable claim 9 is not persuasive because as shown above claim 9 is not allowable and therefore dependent claims 11, 18, 19, 10 and 12-17 are also not allowable.

**THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Steven H. Rao whose telephone number is (703) 3065945. The examiner can normally be reached on 8.00 to 5.00.

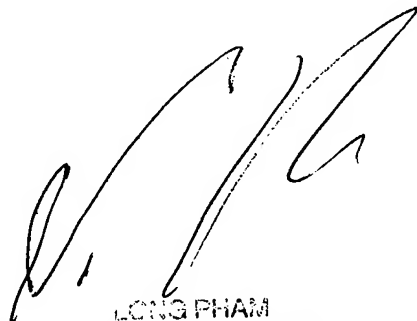
The fax phone numbers for the organization where this application or proceeding is assigned are (703) 7463926 for regular communications and (703) 872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 3067722.



Steven H. Rao

Patent Examiner  
May 20, 2003.  
~~May 30, 2003.~~



LONG PHAM  
PRIMARY EXAMINER